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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/833,377	Applicant(s) CAHILL, NATHAN D.
	Examiner Kevin Siangchin	Art Unit 2623

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on *20 July 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-26 and 45-54* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-26 and 45-54* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

Detailed Action

Specification

Response to Amendments to the Specification

1. The amendments to the Specification, filed July 20, 2004, have been acknowledged. The proposed changes resolve the objections posed in the previous Office Action (Mailing Date: March 16, 2004) without introducing new matter.

Claims

Response to Amendments to the Claims

2. The amendment to the Claims, filed July 20, 2004, has been made of record. Claims 1-2 and 13-15 have been amended accordingly. Claims 27-44 have been canceled. Claims 45-54 have been added.

Response to Arguments and Remarks

3. The amendments to Claims 1 and 14 adequately address the claims objections set forth in the previous Office Action. Therefore, all previous claim objections have been withdrawn.

4. With regard to the rejections under U.S.C. § 101 (non-statutory subject matter), the Applicant has amended Claims 1-26 such that all prior U.S.C. § 101 rejections are overcome. Specifically, these claims now propose methods and apparatuses for "fitting a plurality of sub-population functions to *digital image data*". These constitute practical applications (i.e. applications to digital image data) of the strictly mathematical and/or algorithmic processes of the original Claims. The claimed subject matter is, therefore, considered statutory, as per U.S.C. § 101.

5. The Applicant's amendments overcome the U.S.C. § 112(2) rejections of Claims 1, 13, 14, 26. These rejections have, therefore, been withdrawn. However, the issues raised in the previous Office Action with respect to

Claims 6 and 19 still remain. The Applicant has not amended Claims 6 and 19 in any way to resolve these issues. The deficiencies of Claims 6 and 19 will be addressed in greater detail below.

6. On pages 14 (paragraph 2) of the Amendment (filed July 20, 2004), the Applicant states the following:

> [T]he limitations from Claim 2 have been incorporated into independent Claim 1. Since Claim 2 was not otherwise objected to or rejected, claim l and its dependencies should now be in allowable form.

On the contrary, Claim 2 was rejected in the previous Office Action. Please refer to paragraphs 35-38 on pages 11-13 of the previous Office Action. Therefore, amended Claim 1 cannot be considered allowable as a matter of course, as proposed by the Applicant in the excerpt above.

7. Although the rejection of Claim 2 would have been clear upon a thorough reading and deliberation of the previous Office Action, an "official" statement of rejection for Claim 2 was inadvertently omitted from the previous Office Action. Claim 2 was not among the claims listed in the statement of rejection on page 11 (paragraph 34). However, it should be clear from the paragraphs that follow that Claim 2 was intended to be among those rejected claims, and the justification for its rejection was provided. Again, please refer to paragraphs 35-38 on pages 11-13 of the previous Office Action. This omission will be treated, herein, as a typographical error and, for the purposes of this document, Claim 2 stands rejected under U.S.C. § 103(a).

8. Similar remarks apply to the original rejection of Claim 15 and the Applicant's statements on page 15, paragraph 3 of the Amendment. With regard to Claim 15, please refer to paragraph 41 on page 14 of the previous Office Action. Similar remarks apply to the original rejections of Claims 7-8 and 20-21. With regard to Claims 7-8 and 20-21, please refer to paragraphs 39-41 on pages 13-14 of the previous Office Action.

9. In order to properly resolve the original claim rejections under U.S.C. § 103(a), the statements of rejection will be repeated, as they were intended to appear:

10. Claims 2, 7-8, 15, 20-21, and 27-32, 34-41, and 43-44 are rejected under 35 U.S.C. § 103(a) as being unpatentable over [Snyder90] (W. Snyder et al., *Optimal Thresholding – A New Approach*, Pattern Recognition Letters 11, 1990), in view of [Neves96] (N. Neves et al., *A Study of a Non-Linear Optimization Problem Using a Distributed Genetic Algorithm*, International Conference on Parallel Processing, 1996).

11. Claims 10 and 23 are rejected under 35 U.S.C. § 103(a) as being unpatentable over [Snyder90], in view of [Levine99] (D. Levine, *Statistics For Managers Using Microsoft Excel: Chapter 14 – Multiple Regression Models*, Prentice-Hall, 1999).

12. Claims 33 and 42 are rejected under 35 U.S.C. § 103(a) as being unpatentable over [Snyder90], in view of [Neves96], in further view of [Levine99].

Objections

13. Claim 25 is objected to. Claim 25 should have been amended in the same manner as Claim 13.

14. Claims 45 and 54 are objected to. In line 11 of Claims 45 and 54, the semi-colon (;) between the words "generation" and "wherein" should be changed to a comma (,).

Rejections Under 35 U.S.C. § 112(2)

15. The following is a quotation of the second paragraph of 35 U.S.C. § 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

16. Claim 6, 19, 45 and 54 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

17. *The following is in regard to Claims 6 and 19.* Claim 6 recites:

> The method of Claim 1, wherein said objective function is defined as a vector representation of said plurality of function parameters.

As discussed in the previous Office Action (page 5, paragraph 15), defining the objective function "as a vector representation" of the function parameters is not only inconsistent with the Applicant's Specification, but is also inconsistent with Prior Art optimization techniques. Generally, in optimization problems, an *objective function* is a function which determines how good a solution is. In solving an optimization problem, one attempts to find a feasible solution that optimizes (e.g. minimizes or maximizes) the associated objective function. The Applicant's disclosed invention can be cast in terms of an optimization problem. Indeed, the goal of the Applicant's invention is to obtain a globally optimal solution that minimizes a given objective (or fitness) function (e.g. Applicant's

equations (3) or (26)). That solution constitutes a statistical (Gaussian mixture) model which approximates an empirical representation of a given image (e.g. a histogram).

18. The derived mixture model can be represented as a vector of the statistical parameters that define each of the model's constituent Gaussian distributions. The objective function, on the other hand, provides a measure of the *goodness-of-fit* between the derived model and the given idealized or empirical model. In general, this requires only a scalar representation (i.e. though the objective function may take multi-dimensional vectors as arguments, the objective function returns a *scalar* value). This is evidenced by the various objective functions (e.g. equations (3) and (26)) disclosed by the Applicant. If it was not already apparent, the objective function is completely different – conceptually, mathematically, and functionally – from the derived Gaussian mixture model: *the objective function is not the same as the model being derived.* The Applicant acknowledges this distinction in certain parts of the Amendment (e.g. Claims 45 and 47) and the original Specification, yet insists in other portions of the Amendment (e.g. page 14 of the Amendment) that the objective function be defined in terms of a vector representation – in other words, that the objective function have a similar representation as the derived model. Despite the Applicant's arguments, Claims 6 and 19 remain inconsistent with the Applicant's own disclosure and, moreover, with the conventional notion of an objective function in the field of optimization theory. As in the previous Office Action, it will be assumed that the Applicant intended to refer to the aforementioned *model* (i.e. the Gaussian mixture model) where "objective function" appears in Claims 6 and 19.

19. *The following is in regard to Claims 45 and 54.* On lines 22-24 of Claim 45, the Applicant states the following:

> altering said chromosomes and repeating said *producing*, first and second defining, and forming steps, if none of said fitness values satisfies said stopping criteria...

It is assumed that the "said producing" refers to the step of "producing a histogram" proposed in lines 3-4 of Claim 45. The excerpt above is inconsistent with the Applicant's disclosure and Claim 1. The histogram is not repeatedly produced, according to the Applicant's disclosed invention. See Claim 1 (lines 11-14), Figs. 1 and 4, paragraph 1

(last sentence) of the Summary of the Invention on page 4 of the Specification, paragraph[1] 1 (last sentence) on page 5 of the Specification, and paragraph 1 (next to last sentence) on page 6 of the Specification.

20. For the remainder of this document, it will be assumed that lines 22-24 of Claim 45 were intended to state:

> altering said chromosomes and repeating said first and second defining, and forming steps, if none of said fitness values satisfies said stopping criteria...

21. Similar arguments apply for Claim 54.

Rejections Under 35 U.S.C. § 112(1)

22. The following is a quotation of the first paragraph of 35 U.S.C. § 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

23. Claim 6 and 19 are rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. This follows from the previous discussion. Clearly, there is no support, in the Applicant's Specification, for an objective function defined as a vector representation of a plurality of function parameters.

24. Claim 45 and 54 are rejected under 35 U.S.C. § 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. As discussed above, the Applicant's disclosure does not support the repeating of the "producing [histogram step]... if none of said fitness values satisfies said stopping criteria".

Rejections Under 35 U.S.C. § 103(a)

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1 When referring to paragraphs in the cited references, the convention followed here is that the paragraph number is assigned to paragraphs of a given column (if applicable) or section, sequentially, beginning with the first full paragraph. Paragraphs that carry over to other columns will be referred to as the last paragraph of the column in which they began.

25. The following is a quotation of 35 U.S.C. § 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

26. Claims 1-9, 11-22, and 24-26 are rejected under 35 U.S.C. § 103(a) as being unpatentable over [Snyder90] (W. Snyder et al., *Optimal Thresholding – A New Approach*, Pattern Recognition Letters 11, 1990), in view of [Neves96] (N. Neves et al., *A Study of a Non-Linear Optimization Problem Using a Distributed Genetic Algorithm*, International Conference on Parallel Processing, 1996).

27. *The following is in regard to Claims 1 and 14.* The Applicant has amended Claim 1 so as to incorporate limitations from Claim 2. The original language of Claim 2, therefore, encompasses all subject matter currently claimed in the amended Claim 1, with the exception of the limitation of "digital image data".

28. Recall from the previous Office Action (paragraphs 35-38 on pages 11-13; see also paragraph 23 on pages 8-9) and the discussion above, that Claim 2 was originally rejected under U.S.C. § 103(a) as being unpatentable over [Snyder90], in view of [Neves96]. That discussion made no assumptions about the data being modeled and, therefore, would apply generally to all types of data, including digital image data. Furthermore, the methodology disclosed in [Snyder90] is clearly directed to digital image data (see, for example, paragraphs 1 and 4 in Section 1 of [Snyder90]). The rejection of amended Claim 1, therefore, follows directly from the rejection of original Claim 2 presented in the previous Office Action. For the sake of brevity, that discussion will not be repeated here. Please refer to paragraph 23 on pages 8-9 and paragraphs 35-38 on pages 11-13 of the previous Office Action.

29. Similar arguments apply to amended Claim 14. Please refer to the discussion of original Claim 15 on page 14, paragraph 41 of the previous Office Action.

30. *The following is in regard to Claim 2, 6, 15, and 19.* Recall that, in the previous Office Action, Claim 6 was interpreted as: "The method of Claim 1, wherein said *modeling function* is defined as a vector representation of said plurality of function parameters". See paragraph 13 on page 5 of the previous Office Action. The "modeling function" of the previous Office Action and the "model" of amended Claim 2 are synonymous. The discussion in the

previous Office Action regarding Claim 6, therefore, addresses all limitations of amended Claim 2. For the sake of brevity, that discussion will be not be repeated here. Please refer to paragraph 6 on page 9 of the previous Office Action.

31. Notice that the current Claims 2 and 6 are interpreted similarly in this document (see the 35 U.S.C. § 112(2) rejections above). Therefore, the discussion above with respect to Claim 2 applies to Claim 6 as well.

32. The rejections of the current Claims 15 and 19 follow similarly. Please refer additionally to paragraph 32 on page 11 of the previous Office Action.

33. *The following is in regard to Claims 3-9, 11-13, 16-22, and 24-26.* The Applicant has not amended these claims[2]. The rejections of Claims 3-9, 11-13, 16-22, and 24-26 follow directly from the arguments presented in the previous Office related to these claims, as well as the discussions above relating to the claims upon which they depend. For the sake of brevity, those arguments will be omitted here. Please refer to the appropriate sections of the previous Office Action.

34. Claims 10 and 23 are rejected under 35 U.S.C. § 103(a) as being unpatentable over [Snyder90], in view of [Neves96], in further view of [Levine99] (D. Levine, *Statistics For Managers Using Microsoft Excel: Chapter 14 – Multiple Regression Models*, Prentice-Hall, 1999).

35. *The following is in regard to Claims 10 and 23.* As discussed above an the previous Office Action, [Snyder90] and [Neves96] can be combined to yield a method in accordance with Claim 1. Neither [Snyder90] nor [Neves96], however, suggest utilizing a statistical *F*-test to evaluate the relative contribution of each of the plurality of functions in comparison of the fitting error and the data.

36. As discussed in the previous Office Action (page 19, paragraph 54), the *F*-test is a well-known statistical test used to determine whether two populations have equal variances. It is frequently used to analyze the goodness-of-fit of linear regression models. (Least-squares fitting, such as performed in the applicant's claimed fitting method

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2 Claim 13 has been amended to overcome objections and/or 35 U.S.C. § 112(2) rejections made in the previous Office Action. Claim 13 was originally rejected under the assumption that the words "modeling function" appeared instead of "objective function". As mentioned above, "modeling function" and "model" are synonymous. Therefore, the limitations of Claim 13 have been addressed in the previous Office Action.

and discussed by both [Snyder90] and [Neves96], is a form of linear regression). A common application of the *F*-test is to analyze the contribution of an independent variable to the goodness-of-fit of a model that depends on multiple independent variables. See [Levine99] slides 14-18 to 14-23.

37. Note that the mixture models discussed by [Snyder90] (and those used in the applicant's fitting method) represent models (i.e. the modeling functions) that depend on multiple independent variables (i.e. the basis functions). Consequently, the *F*-test can be used to analyze the modeling functions of [Snyder90] in the manner described above. It would be straightforward for one of ordinary skill in the art to incorporate the *F*-test into the objective function of Snyder, thereby providing an additional measure of the goodness-of-fit of the modeling function to the input data. Clearly, one is motivated to do so to provide a more precise measure of the goodness-of-fit of the modeling function to the input data, in addition to providing a measure of the optimal number of basis functions to use in the modeling function[3]. Given the straightforwardness of such a modification and its clear advantages, it would have been obvious to one of ordinary skill in the art, at the time of the applicant's claimed invention, to incorporate the *F*-test into the objective function of the fitting technique, obtained by combining [Snyder90] and [Neves96]. In doing so, one would obtain a fitting method, in accordance with Claim 1, further comprising using an *F*-test to evaluate the relative contribution of each of the basis functions when comparing the objective function to the stopping criteria. Such a fitting method conforms to all limitations of Claim 10.

38. The rejection of Claim 23 follows similarly.

39. Claims 45-50 and 52-54 are rejected under 35 U.S.C. § 103(a) as being unpatentable over [Snyder90], in view of [Neves96], in further view of [Mitchell94] (M. Mitchell and S. Forrest, *Genetic Algorithms and Artificial Life*, Artificial Life Vol. 1(3), 1994).

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3 Since the *F*-test provides a measure of the contribution of a basis function to the goodness-of-fit of the modeling function, modeling functions with extraneous basis functions (i.e. *basis functions* [see the previous Office Action] that make little contribution to the goodness-of-fit) can be considered less optimal.

40. *The following is in regard to Claim 45.* As shown in [Snyder90] and in the previous Office Action, [Snyder90] discloses a method for specifying thresholds (i.e. *optimal thresholding* – [Snyder90] Abstract) for segmenting a digital image. The method of [Snyder90] comprises:

(45.a.) Producing a histogram of the image ([Snyder90] Section 1, paragraph 1, sentence 1).

(45.b.) Defining a mixture model (e.g. Gaussian mixture model, $h(x)$ – equation (1) of [Snyder90]) as a combination (e.g. a weighted sum – cf. [Snyder90] equation (1)) of a plurality (e.g. d – see [Snyder90] Section 1, paragraph 2, sentence 1) of subpopulations (e.g. Gaussians $\left\{\frac{1}{\sqrt{2\pi\sigma_i}}\exp\left[-\frac{(x-\mu_i)^2}{\sigma_i^2}\right]\right\}_{i=1...d}$), wherein each subpopulation is a function defined according to a plurality of function parameters (i.e. means μ_i and variances σ_i). Refer, generally, to [Snyder90] equation (1).

(45.c$_{\text{Snyder}}$.) Defining a vector (e.g. Θ – cf. equation (5)[4]) encoding the mixture model, wherein elements of the vector encode the plurality of function parameters of the plurality of sub-populations. See the last paragraph of the right column on page 803of [Snyder90].

(45.d$_{\text{Snyder}}$.) A "generation" is formed of a plurality of vectors, at each iteration of the algorithm. [Snyder90] proposes two approaches to optimization: gradient descent ([Snyder90], Section 2) and simulated tree-annealing ([Snyder90], Section 3). In the first approach the generation is a collection of vectors $\Theta^{(k)}$ at iteration k (cf. equation (6) in [Snyder90], Section 2, paragraph 1). According to the second approach, the generation comprises the vectors (solutions) x and y in each iteration of the algorithm[5] (cf. [Snyder90] page 806, left column, paragraphs 1 and 2 (*Steps 1-2*), Section 3.1, and paragraph 1 of Section 3.2).

(45.e$_{\text{Snyder}}$.) For each vector (Θ) in the "generation" (i.e. for each iteration):

4 Technically, equation (5) of [Snyder90] expresses the collection of Gaussian parameters Θ as a set. Clearly, this set can be trivially expressed as a vector. While a set and vector are mathematically different, for the purposes of the algorithm disclosed by Snyder et al. and the method proposed by the applicant, they both represent collections of data and, therefore, can be treated as the same.

5 Another way of looking at this is that at each iteration the search space S is reduced. The vectors that remain in the search space collectively constitute a generation.

1. Determining the fitting error (e.g. objective function, H – [Snyder90] equation (4)) between the mixture model (e.g. $h(x,\Theta)$ – [Snyder90] equation (4)) and the histogram data (e.g. h_j –[Snyder90] equation (4)). Refer to equation (4) of [Snyder90], paragraph 1 of Section 2, and second to last paragraph in the right column of page 805.
2. Determining a measure of relative contributions (e.g. P_i – cf. equations (1) and (3) of [Snyder90]) of the individual sub-populations (e.g. the aforementioned Gaussians) defined by each vector (Θ). The optimal values for the weights P_i are determined along with the optimal values for the collection Gaussian parameters (cf. last two paragraphs in Section 1 of [Snyder90]).
3. Determining a fitness value (e.g. objective function, H – see equation (4)) based on the fitting error (e.g. the square error $[h_j - h(x_j,\Theta)]^2$ – see equation (4) of [Snyder90]). Note that this value is also based, *inter alia*, on said measure of relative contributions (P_i). To see this notice that $h(x,\Theta)$ is a function of Θ, which includes the parameters P_i (cf. [Snyder90] equations (1), (4), and (5)). Clearly then, the fitness value, $H(x)$, is dependent on the relative contributions P_i.
4. Comparing said fitness values to a stopping criterion. Optimization methods generally require some predefined stopping criteria for evaluating the convergence to a solution. A stopping criterion is, therefore, inherent to the method of [Snyder90]. Gradient descent typically terminates when the error becomes sufficiently small and the algorithm has approximately converged to a solution. In simulated annealing, the algorithm terminates when the temperature (T – see [Snyder90] page 806, left column, *Step 2* and Section 3.3) cools to some predefined value, or when some other stopping criterion has been met. Official Notice is taken.

($45.f_{Snyder}$.) 1. Altering the vectors (cf. [Snyder90] equation (6), *Step 2* in the left column of page 806, and *Steps 3-4* in the right column of page 806).

As discussed above, the method [Snyder90] iterates until it converges to a solution (i.e. the until the stopping criterion (or criteria) is satisfied) or has exhausted the entire search space (S – see the second to last paragraph in the right column of page 805 of [Snyder90]). In other words, [Snyder90] further compises:

2. Repeating said first and second defining (i.e. steps (45.b.)- (45.c_{Snyder}.) above), and forming steps (i.e. step (45.d_{Snyder}.)), if none of said fitness values satisfies said stopping criteria.

(45.g.) Specifying at least a first threshold value delineating said sub-populations in the mixture model (cf. [Snyder90] Section 1, paragraphs 1-2) if at least one of said fitness values satisfies said stopping criteria. As discussed above, the algorithm converges to an optimal vector Θ (i.e. Θ in S having a "fitness value satisfying the stopping criteria"). That Θ represents the Gaussian mixture which fits the given histogram optimally. [Snyder90] uses this mixture model to derive the optimal thresholds for segmenting the various modes of the given histogram.

Notice that [Snyder90] uses simulated annealing to achieve optimization, as opposed to a genetic algorithm. Therefore, the search space is not encoded as set of *chromosomes*.

41. As discussed in the previous Office Action, [Neves96] suggest the application of genetic algorithms to optimization problems which involve the least-squares fitting a model to a set of empirical data. Such optimization problems are analogous to that of [Snyder90] (cf. paragraphs 1 and 4 in Section 4 of [Neves96]; note in particular the similarity of the first and third equations to equation (4) of [Snyder90]). Specifically, both [Snyder90] and [Neves96] attempt to find a set of parameters (i.e. X in [Neves96] and Θ in [Snyder90]) that minimize the square error between the model (i.e. f in [Neves96] and h in [Snyder90]) and the empirical data (i.e. cal data (i.e. $y(t_i)$ in [Neves96] and h_j in [Snyder90]). Genetic algorithms (GA) and simulated annealing (SA) are competing heuristics in the field of optimizations, and both have been used to solve the same types of problems. Simulated annealing algorithms, however, are generally more difficult to implement than genetic algorithms. The algorithm must be tailored specifically to the given application in order to ensure convergence (cf. paragraph 1, lines 13-18 in Section 2 of [Neves96], and paragraph 2, sentences 1-2 in Section 2 of [Neves96]). Other advantages of GA were discussed in

paragraph 43 on pages 16-17 of the previous Office Action. Therefore, given these advantages and the teachings of [Neves96], it would have been obvious to one of ordinary skill in the art, at the time of the Applicant's claimed invention, to use GA to determine the optimal Gaussian mixture (i.e. the optimal parameter set Θ) in the optimal thresholding method of [Snyder90].

42. Aside from discussing the notion of "generations" within the context of genetic algorithms ([Neves96] Section 2, paragraph 2), [Neves96] does not provide a detailed description of these algorithms. It is well known, however, that GA act on populations of chromosomes and the complete set of chromosomes, otherwise known as a *genome*. The genome is analogous to the Applicant's "master chromosome", in the sense that it encodes the complete array of "genetic" information (*genes*) contained in all chromosomes. Chromosomes and genomes are essential structures in genetic algorithms. [Mitchell94] shows this, for example, on page 2 (paragraph 3), page 7 (paragraph 1), and page 9 (paragraph 2). A general overview of GA appears in Section 2 of [Mitchell94]. Notice from that discussion that GA comprises the following steps:

(45.$c_{Mitchell}$.) Defining chromosomes that encode candidate solutions to a problem (cf. *Step 1* and *Step 3* in [Mitchell94], Section 2).

(45.$d_{Mitchell}$.) A generation is formed of a plurality of chromosomes (cf. *Step 1* and *Step 3* in [Mitchell94], Section 2; see also line 3 on page 3 of [Mitchell94]). As discussed above, the *genes* ([Mitchell94], Section 2, lines 8-9) of these chromosomes constitute a genome, or "master chromosome".

(45.$e_{Mitchell}$.) For each chromosome in the generation:

1. Determining the fitness of each chromosome.

(45.$f_{Mitchell}$.)

1. Altering the chromosomes (cf. *Step 3* in [Mitchell94], Section 2).
2. Repeat the defining step (45.$c_{Mitchell}$.), the forming step (45.$d_{Mitchell}$.), and the fitness determination step (45.$e_{Mitchell}$.). Clearly, the algorithm does not iterate *ad infinitum*. Therefore, the GA must entail some stopping criterion, which indicates when the said repeating should cease.

[Mitchell94] suggests the application of GA to optimization problems ([Mitchell94], page 3, paragraph 2). Therefore, it would have been obvious to one of ordinary skill in the art, at the time of the Applicant's claimed

invention, to apply GA to optimization problems and, more particularly, to the optimization problems of [Snyder90] and [Neves96]. Notice the similarities between (45.c_{Snyder}.)-(45.f_{Snyder}.) of [Snyder90] and (45.$c_{Mitchell}$.)-(45.$f_{Mitchell}$.). Clearly, a GA implementation of steps (45.c_{Snyder}.)-(45.f_{Snyder}.) of [Snyder90] would comprise, in addition to steps (45.a.)-(45.b.) and (45.g.):

(45.c.) Defining a chromosome to be a vector encoding of the mixture model, wherein elements of the vector encode the plurality of function parameters of the plurality of sub-populations.

(45.d.) Forming a generation, wherein a generation comprises of a plurality of chromosomes and a genome.

(45.e.) For each vector (Θ) in the "generation" (i.e. for each iteration):

1. Determining the fitting error between the mixture model and the histogram data.
2. Determining a measure of relative contributions of the individual sub-populations defined by the chromosomes.
3. Determining a fitness value based on the fitting error and the measure of relative contribution.
4. Comparing said fitness values to a stopping criterion.

(45.f.)

1. Altering the chromosomes.
2. Repeating said first and second defining, and forming steps, if none of said fitness values satisfies said stopping criteria.

Similar arguments apply for Claim 54.

43. *The following is in regard to Claim 47.* The limitations of Claim 47 were treated above with respect to amended Claim 2. Please refer to that discussion and the associated sections of the previous Office Action.

44. *The following is in regard to Claims 46, 48, 49, 52, and 53.* These claims recite substantially the same limitations as Claims 4, 8, 12, and 13, respectively. These limitations have been treated above and in the previous Office Action. For the sake of brevity, that discussion will not be repeated here. Please refer to the following sections of the previous Office Action: paragraph 25 on page 9, paragraph 40 on page 14, and paragraphs 30-31 on page 10.

45. *The following is in regard to Claim 45.* As discussed above, in the method of [Snyder90], a plurality (mixture) of Gaussians (normal distributions) are fit to the histogram data. The parameter set Θ includes the means , μ_i, and standard deviations, σ_i (cf. equation (5) of [Snyder90]).

46. Claims 51 are rejected under 35 U.S.C. § 103(a) as being unpatentable over [Snyder90], [Neves96], and [Mitchell94], in further view of [Levine99].

47. *The following is in regard to Claim 51.* The limitations of Claim 51 were treated above and in the previous Office Action. Please refer to the discussion above and in paragraphs 53-55 on pages 19-20 of the previous Office Action.

Conclusion

48. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

49. A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Kevin Siangchin whose telephone number is (703)305-7569. The examiner can normally be reached on 9:00am - 5:30pm, Monday - Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amelia Au can be reached on (703)308-6604. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Kevin Siangchin

Examiner
Art Unit 2623

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